Teaching sterile skills in anesthesia

Is providing context helpful for robust skill acquisition?

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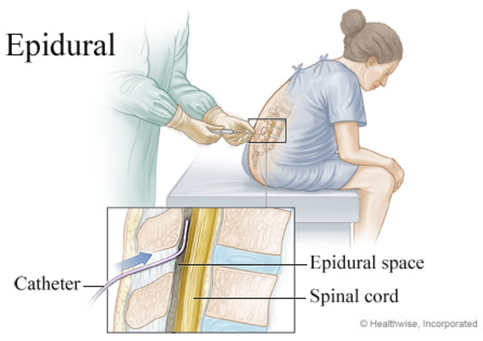
EPIDURAL ANESTHESIA

- Pain relief method during childbirth and during and after operations
- As it is an **invasive** technique, it carries the risk of **contamination**
- Residents basically learn the procedure in the clinic
- **Even after 4 years of training, residents still make sterility errors** (Friedman *et al*, 2008)
  - sterility is a complex concept
  - sterility is not visible



PRESENT TRAINING IS NOT OPTIMAL

- **Medical skills should be flexible and robust** (Cnossen, 2015)
  - Flexible: applicable outside context in which it was learned
  - Robust: resistent to stress and workload
- Present training of complex procedures often **focuses on the order of the steps of the procedure**
- This makes learning **vulnerable**
  - steps may be forgotten and skipped
  - steps may be performed in the wrong order
- In practice there is **no fixed order of steps**
  - different procedures have different steps, equipment, medication
  - not all steps have to be performed in a strict order
  - in practice, every supervisor has their own preferred order and method
- Focus on the steps in the procedure during learning
  - **does not lead to flexibility** in the skill
    - what if a step cannot be performed
  - **does not lead to robustness** of the skill
    - in stress situation memory errors can happen

DIFFERENT APPROACH: FOCUS ON THE CONTEXT

- Taatgen, Huss, Dickison & Anderson (2005) showed that in teaching flexible cognitive skills teaching materials should draw attention to
  - the **pre-conditions** of actions (knowing when)
  - the **post-conditions** of actions (knowing the effects of actions in the environment)
- They found that Boeing pilots were more flexible and the skill was more robust after learning with a focus on these environmental cues
  - learners can then rely on **environmental cues** rather than keeping track of all the executed steps in their mind
- We applied this approach to training preparing and executing epidural anesthesia

METHOD

- 37 medical students participated in simulation study
- Skill: **preparation of epidural anesthesia**
  - 34 steps
  - 10-15 minutes

Procedure
- Video instruction of procedure
- Studying description of steps on paper
  - non-sterile actions were written in red
  - sterile actions were written in green
- 15 minutes practice with materials and instruction sheets
- Test: perform the procedure with an *"non-obstructive nurse"*

Instructions
- **List condition**
  - 34 steps in chronological, strict, order
- **Context condition**
  - steps arranged in sets
    - order within set was not important
  - photographs
    - pre-conditions of a set of actions (*"before"*)
    - post-condition (*"after"*)
  - description of the actions to be performed within the set

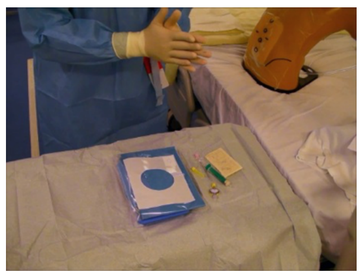
LIST CONDITION

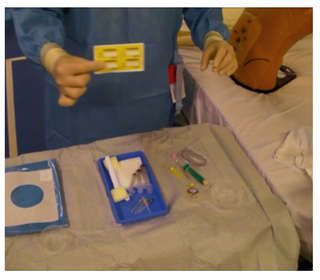
II. Klaarzetten

Jezelf Steriel Maken:
7. Desinfecteer je handen
8. Trek de steriele jas aan
9. Trek de handschoenen aan

Materiaal Op Tafel Positioneren:
10. Naalden in blauwe bak
11. Kleine bakje boven epiduraalnaaldset
12. Grote bakje, voor roze Chloorhexidine, in andere bovenhoek
13. Geef de gele sticker aan de 2e persoon

CONTEXT CONDITION



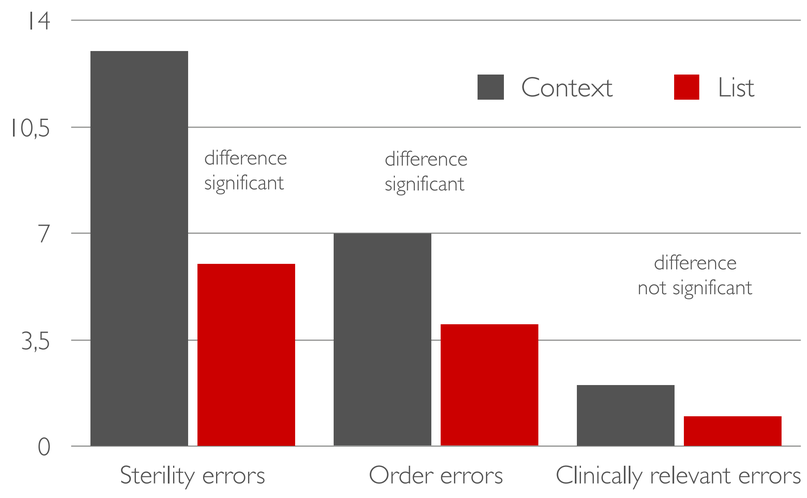


Ervoor **Erna**

Wanneer:
Als je zelf steriel bent

Eindsituatie:
- Naalden in blauwe bakje
- Kleine bakje boven epiduraal-naaldenset
- Grote bak voor roze chloorhexidine in andere bovenhoek

MAIN RESULTS



DISCUSSION

- **Contrary to expectation the context condition did not result in robust skill**
  - This stands in contrast to Taatgen *et al*'s study
- Context condition even resulted in more sterility errors than the list condition

Why?

Environmental cues
- In epidural anesthesia procedure, there are also many **environmental cues in *list* condition** (eg syringe filled or empty?)
  - Boeing pilots used complicated system with low usability, so possibly profited more from context

Memory load
- Context condition possibly imposed larger **memory load** on participants
- The known advantages of the context method were at least partly offset by the disadvantages of this high memory load

Sterility
- Apparently, **sterility errors are difficult to prevent**, even though we explicitly noted which steps of the procedures were sterile or not
- The participants in the experiment were probably unfamiliar with the concept of sterility
- **Sterility is a complex concept**
  - it is not obvious for example that crossing a sterile workspace with (unsterile) bare underarms is not sterile

CONCLUSIONS & RECOMMENDATIONS

- **Complex medical skills involve many steps and induce a high memory load to learn them**
- Providing context when teaching a procedure may therefore not necessarily lead to better skill acquisition than learning the steps
  - but the resulting skill may be more flexible and robust after context-learning
- Further research is needed to test whether it may be advantageous to first study the steps in a procedure until all steps are remembered before performing the skill
  - separating studying the declarative knowledge from training the procedural skill
  - we can then also test the flexibility and robustness of the skill
- Further research is needed to test whether **teaching sterility concepts separately** from the procedure itself is needed

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